



STATE OF WASHINGTON
DEPARTMENT OF ECOLOGY

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October 31, 2003

Mr. Allen Fiksdal, Manager
Energy Facility Site Evaluation Council
P.O. Box 43172
Olympia, Washington 98504-3172

RECEIVED

NOV 03 2003

Dear Mr. Fiksdal:

Re: Comments on the Draft Environmental Impact Statement (DEIS) for the BP Cherry Point Cogeneration Facility.

ENERGY FACILITY SITE
EVALUATION COUNCIL

Thank you for providing the Department of Ecology (Ecology) with the opportunity to comment on the DEIS for the BP Cherry Point Cogeneration Facility. We have reviewed the wetland portions of the DEIS and have the following comments:

- Section 1.6.8 of the DEIS states that many aspects of the Custer/Intalco Transmission Line No. 2 remain to be resolved such as the number, type and location of potentially new transmission towers, access roads, culverts and temporary laydown, staging and assembly areas. Any or all of these features could impact wetlands, and these potential impacts have not been identified. In addition, there is no mitigation proposed for these potential impacts. The Site Certification Agreement should be conditioned to require that, if new towers need to be built in the Line No. 2 easement, detailed wetland delineations will be completed, impacts assessed, and appropriate wetland mitigation designed and planned in conjunction with, but in addition to the current proposed plan.
- Using stormwater in the mitigation area has implications for water quality as well as water quantity. A condition should be included in the Site Certification Agreement or 401 Water Quality Certification that requires monitoring of stormwater before it enters the mitigation area. Stormwater should be monitored at regular intervals and during and immediately after larger storm events to ensure that stormwater is adequately treated. If state water quality standards are exceeded, contingency measures will need to be identified and implemented.
- Although well thought out, the wetland mitigation proposal is still in a conceptual phase. The plan briefly discusses certain elements such as excavating shallow swales and other topographic modifications, but the extent and locations of these swales and modifications is not shown. Ecology recommends that the Site Certification Agreement and subsequent 401 Water Quality Certification be conditioned to require a final wetland mitigation plan. Specifically, the following elements should be included:

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Mr. Allen Fiksdal
October 31, 2003
Page 2

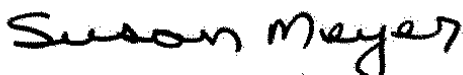
- A detailed grading plan. - This should include the exact location of the inlet channel and disperser outlets at the appropriate elevation to minimize the need for excavating shallow swales for conveying water across higher ground. Also, the mitigation plan refers to weirs in the inlet channel. Weirs should not be used in the mitigation area, since the idea behind the hydrologic restoration component of the plan was to eliminate engineered and artificial features such as ditches, to the extent possible. Although the inlet channel is necessary to convey the stormwater, it should be designed to function as simply as possible.
 - Specifics on the planting plan, such as which species will be planted in what locations in which year. - At this time there is discussion about phased planting, which seems appropriate, but more detail is needed in a final plan.
-
- Figure 3.5-2 does not accurately reflect the wetland communities in the area. At least part of the "MF" forested area north of Brown Road in the location of the previously permitted transmission line is a forested wetland mosaic. The figure is deceiving in that it leads the reader to assume the area is mixed coniferous/deciduous forest, but not wetland. Most of the wetland areas depicted on this figure are shown as grasslands, when in fact, there are forested wetlands as well. This figure should be revised.

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cont.

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Once again, thank you for the opportunity to comment. If you have any questions, please phone me at 425-649-7168.

Sincerely,



Susan Meyer, Wetland Specialist
Shorelands and Environmental Assistance Program

cc: Jeannie Summerhays, Ecology

Environment
CanadaEnvironnement
CanadaBP Cherry Point Cogen
DEIS Comment - 22

November 3, 2003

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ENERGY FACILITY SITE
EVALUATION COUNCIL

BY FAX (360) 956-2158

Dear Mr. Fiksdal:

Re: **Comments on BP Cherry Point Cogeneration Project DEIS**

I write to provide Environment Canada's comments on the September 5, 2003, Draft Environmental Impact Statement (DEIS) for the proposed BP Cherry Point Cogeneration Project ("the project"). The DEIS provides a comprehensive overview of potential environmental impacts of the project. Nonetheless, in Environment Canada's view, the final Environmental Impact Statement (EIS) should also address the issues outlined below.

The following comments draw upon an analysis of the DEIS conducted by a technical review team comprised of representatives from the Greater Vancouver Regional District, the Fraser Valley Regional District, the B.C. Ministry of Water, Land and Air Protection, and Environment Canada. I understand that this analysis has been forwarded to EFSEC by the Greater Vancouver Regional District. The technical review team analyzed air quality and greenhouse gas related impacts only, because no other environmental impacts in Canada are anticipated.

These comments address improvements to the DEIS only; Environment Canada may provide comments with respect to the project itself at the public comment stage, expected in December, 2003.

Health Effects

There is a substantial and growing body of evidence that suggests that adverse health effects would be predicted at particulate matter (less than 2.5 microns) and ozone exposure levels currently experienced in the Lower Fraser Valley.

For example, Bates et al (2003) concluded that: "*Levels of some air pollutants, particularly PM_{2.5} and its wood smoke component, and ozone, in British Columbia are at levels which, on the basis of comparisons with international data, would be predicted to be causing adverse health effects,*" and went on to recommend that: "*...any improvement in air quality for PM or ozone would result in fewer negative health impacts.*"¹ In 2001, Lower Fraser Valley Medical Health Officers stated that: "*Air pollution is an important public health issue and is linked to illness and death in the lower mainland and elsewhere. This is true despite the fact that current levels of air pollution in the lower mainland are generally stable or lower than they have been in the past and that levels*

¹ Bates, D.V., Brauer, M., Koenig, J. Q., *Health and Air Quality 2002 – Phase 1 – Methods for Estimating and Applying Relationships Between Air Pollution and Health Effects*, British Columbia Lung Association, 2003.

Canada

www.ec.gc.ca

of air pollution in the lower mainland are lower than other major cities in western North America.”² And Vedal et al (2003) concluded from an analysis of data from Vancouver, British Columbia, between 1994 and 1996 that “increases in low concentrations of air pollution are associated with increased daily mortality.”³

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cont.

In order to fully describe the health and environmental impacts of the proposed project, the final EIS should include the implications of this body of evidence with respect to the project.

Particulate Matter

Due to the potential implications of the body of evidence mentioned above, and the fact that the Canada-Wide Standards for Particulate Matter (PM) and Ozone acknowledge this body of evidence and include commitments to “continuous improvement” and “keeping clean areas clean,” the final EIS should include a more thorough analysis of potential ambient concentrations of particulate matter (<2.5 microns).

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Specifically, although the DEIS presents modeling results for worst-case ambient concentrations of PM (at the most-affected location in the Canadian Lower Fraser Valley), we understand that the models used to generate these results did not take into account the formation of secondary particulate matter. Because of the potential importance of exposure of Canadian residents to PM at levels below current objectives, the final EIS should include scientifically credible (for this airshed) modeling of worst-case ambient primary and secondary PM concentrations (including secondary particulate formation from in-plume and ambient ammonia). In order to address the worst case, such modeling should continue to ignore any “refinery offsets” or “PM adjustments,” as in the DEIS, especially for consideration of short-term exposures.

3

Start-Up Scenarios

The DEIS modeled worst-case Canadian ambient concentrations of several pollutants. It is our understanding that these worst cases were defined from “maximum potential emission” scenarios, but that these scenarios did not include start-up scenarios. Informal information received subsequently from the proponent suggests that for some parameters (e.g. nitrogen oxides and carbon monoxide), the worst-case scenario for short-term exposures in Canada may be a start-up scenario. Therefore we conclude that in order to most accurately describe the environmental impacts of the project, the final EIS should include revised ambient concentration modeling results for any parameter and “objective duration” (e.g. <=24 hours) for which a start-up scenario is the worst-case scenario. (Modeled short-duration ambient concentrations should be compared to objectives, including World Health Organization objectives.)

4

Removal of Refinery Boilers

On page 3.2-46, the DEIS states:

Enforceable conditions requiring removal of the refinery's three utility boilers within six months of the beginning of cogeneration facility operation could allow regulatory agencies to more fully take into account refinery emission reductions in the permitting and environmental review process.

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² Copes, R., Blatherwick, J., Guasparini, R., Loewen, N., O'Connor, B., *Air Quality in the Lower Mainland: Patterns, Trends and Human Health*, South Fraser Health Region, 2001.

³ Vedal, S., Brauer, M., White, R., and Petkau, J., *Air Pollution and Daily Mortality in a City with Low Levels of Pollution*, Environmental Health Perspectives, 111:1, 2003.

To facilitate decision-making concerning this potential requirement, the final EIS could include revised worst-case ambient concentration modeling results for the above scenario (i.e. post removal of refinery boilers).

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cont.

Airshed Emissions Context

The DEIS presents estimated expected annual emissions attributable to the project, for several parameters. The final EIS would be more conducive to decision-making if these estimates were presented in the context of the estimated total emissions (for each parameter) in the Lower Fraser Valley / Whatcom County airshed. For example the final EIS might indicate the percentage of airshed emissions that the project would represent, similar to what the DEIS presently does for greenhouse gas emissions. These estimates are available from the Greater Vancouver Regional District's July 2003 *Forecast and Backcast of the 2000 Emission Inventory for the Lower Fraser Valley Airshed 1985-2025*.

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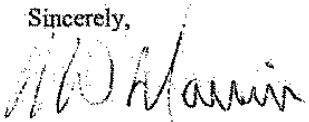
Adjustments to Particulate Matter Emissions Estimates

The treatment of particulate matter emissions in the DEIS is in places confusing and may in some instances be incorrect. Detailed comments are provided in Attachment A.

7

I trust that you will find these comments useful. Overall, the technical review team found the DEIS to provide a helpful description of potential environmental impacts.

Sincerely,



M.D. Nassichuk

Manager, Pollution Prevention and Assessment

/attach.

Cc: Ken Cameron, Greater Vancouver Regional District
Hu Wallis, British Columbia Ministry of Water, Land and Air Protection
Hugh Sloan, Fraser Valley Regional District

Attachment A**Detailed Comments on Section 3.2 of the Draft Environmental Impact Statement**

It would be helpful if the final EIS briefly discussed why expected emissions from the project exceed current emissions from the refinery boilers by different ratios for different parameters. (For example, the maximum potential PM emissions from the project appear to be 26 times higher than PM emissions from the refinery boilers at capacity, while for VOCs this ratio is 14, for SO₂ it is 7, for CO it is 3, and for NO_x it is 0.5.)

7(1)

With regard to determining the effect of refinery boiler NO_x and SO₂ emission reductions on secondary particulate formation, the technical review team suggested to BP representatives in January 2003 that a range of conversion rates (~2% to 40%) should be examined in the DEIS to address the lack of literature on the subject and the uncertainty contained within the conversion rate assumptions. The DEIS did not examine a range of conversion rates. It would be helpful if the final EIS did.

7(2)

In addition, the "one ton NO_x forms one ton PM" and "one ton SO₂ forms one ton PM" simplifications used in the DEIS are incorrect and should be corrected in the final EIS.

7(3)

There is an apparent disagreement between Tables 3.2.8 and 3.2.9, regarding sulfur dioxide and carbon monoxide concentrations. If this is not a true disagreement, then additional clarification would be helpful.

7(4)

There is an apparent disagreement between the modeled maximum PM₁₀ and PM_{2.5} concentrations in Table 3.2.15, and footnote 1 of the same table. Again, if this is not a true disagreement, then additional clarification would be helpful.

7(5)

In Table 3.2-20 the Net Regional Change in PM₁₀ Emissions should be +84 tpy instead of -84. Also, this table is quite confusing. The relationship between the rows could be made clearer in the final EIS. (For example, row 3 is the summation of rows 1 and 2, but this is not made clear.)

7(6)

Table 3.2-23 is confusing as presented. The relationship between the rows could be made clearer in the final EIS. Also, the last row appears to sum net emissions incorrectly.

7(7)

Lower Fraser Valley air quality monitoring data is now available for 2002; this could be substituted for the 2001 data used in the DEIS.

7(8)



Christine O. Gregoire

ATTORNEY GENERAL OF WASHINGTON

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November 3, 2003

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**ENERGY FACILITY SITE
EVALUATION COUNCIL****Re: BP Cherry Point Draft Environmental Impact Statement - Comments**

Dear Mr. Fiksdal,

Below please find comments on the draft environmental impact statement (DEIS) for the BP Cherry Point Power Project. Thank you in advance for consideration of these comments.

Fact Sheet:

Page i, Abstract- This section states that BP proposes to construct and "operate" the 720 MW cogeneration facility. This is not an accurate statement. BP has actively been negotiating the sale of the facility to TransCanada. The sale appears to be imminent. The public has a right to know who will be operating this facility. Many of the environmental impacts and proposed mitigation features of this project are intricately related to operations at the BP Refinery. The sale of the Cogeneration Project has the potential to pose many questions as to the relationship that will exist between the two entities. This relationship and the impacts of sale of the project to TransCanada needs to be addressed throughout the DEIS. Accordingly, TransCanada should be referenced throughout the DEIS as the proposed operator of the facility.

1

Chapter 1 Summary**1.1 Introduction**

Paragraph 1 - See comment above regarding BP's proposed "operation" of the project.

2

Paragraph 2 - This section states that 635 MW of power produced would be for "local" and regional consumption. In fact there is no guarantee whatsoever that power would be for local consumption. The Application for Site Certification (ASC) states that the power will be sold to BPA and put onto the northwest power grid. This being the case, it is not accurate to imply that the power produced will directly serve local demand.

3

1.2 .1 BP Cherry Point Refinery Need

This section states that refinery operations require approximately 85 MW of electricity and that historically the refinery has purchased power from third parties. The section goes on to state that this reliance on third party sources has exposed the refinery to price volatility. Implied is that construction of the facility will reduce this volatility. However, if BP sells the project as anticipated, then the proposed economic incentive would seemingly disappear because BP would

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again be subject to power purchases from a third party provider. The section should acknowledge the proposed sale of the Project by BP and the impacts of the sale including potential price volatility.

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cont.**1.2.2 National and Regional Power Need**

The discussion on regional power need contains no information on supply forecast or conservation. It is not explained whether the WECC and NWPCC forecasts consider generation that is currently under construction and/or permitted within its analysis. What assumptions are made regarding conservation, renewable resources?

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1.4.2 No Action Alternative

This section states the environmental impacts that would be avoided if the project were not built. The section fails, however, to mention the significant greenhouse gas emissions that would be avoided if the facility were not built

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1.6.4 BP Refinery NPDES Permit Changes

This section states that "*Ecology, the agency with jurisdiction over this permit, would address water quality issues that have been raised for the cogeneration project such as impacts of increased salinity and temperature on the herring population, the age and condition of the existing diffuser, and potential cumulative impacts on water quality through this refinery NPDES permit revision process.*" It would seem appropriate that the water quality impacts of the Project be examined as part of this DEIS, rather than being put off for future consideration by Ecology. Accordingly the DEIS should address all of the water quality issues that have been raised.

7

1.6.7 Change of ownership of Cogeneration Project

This section fails to provide details of the potential ownership transfer to TransCanada. Many questions regarding the change of ownership have not been addressed. When would the transfer take place? Would the relationship between the refinery and the Project plant change in any way as a result of the sale? Has BP entered, or are they prepared to enter into a long term contract with TransCanada to ensure the delivery of steam and electricity to the refinery? The section mentions only the effect that the change of ownership would have on the greenhouse gas mitigation options offered. The section should, however, address the numerous other impacts that could potentially be affected by the sale of the Project. (e.g., will the refinery NPDES permit still be utilized for the Projects waste water discharge, or will TransCanada be required to obtain a separate permit?)

8

1.8 Cumulative Impacts**Section 1.8.1 Global Warming**

This section states that is not possible to determine the actual impacts of cumulative GHG emissions on global warming. While it may not be possible to attribute the specific impacts of this facility on specific global warming conditions, there should be a statement that the cumulative operation of this and other fossil fuel fired facilities in the northwest will contribute to the worldwide impacts of global warming. Moreover, this section does not discuss the actual impacts of global warming on the Northwest. Cumulative impacts can not be ignored just

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Page 3

because it is impossible to attribute regional GHG emissions to specific impacts. This section needs to be re written in a manner that objectively and scientifically addresses the global warming issue. As currently written the section offers no substance of merit.

9
cont.**1.8.2 Regional Air Quality**

In this section it states that "purchase of cogeneration steam by the refinery would likely lead to the refinery shutting down three older utility boilers (emphasis added). Many of the heralded benefits of this project have been predicated upon the belief that existing boilers at the refinery will be shutdown, thereby resulting in reduction of certain criteria pollutants. It is disconcerting to this reader that words such as "likely" continue to be used when referring to the relationship between the generation facility and the refinery. In analyzing this project and its environmental impacts it should be made crystal clear as to how the two facilities will operate and interact. If the shutdown of existing boilers is only a hypothetical possibility then, the air quality benefit of removing boilers should not be included in any discussions on regional air quality and impacts.

10

**3.2.3 Impacts of the Proposed Action
Emission Sources and Emission Controls**

This section states that "Anhydrous ammonia would be used in the SCR control system and some unreacted ammonia would exit the facility stack as ammonia "slip." However, this ammonia slip would be limited to 5 ppm." There is no discussion of the impact of this "ammonia slip" on health and or the environment. Is this a significant amount of ammonia slip? Why, or why not. What are the health impacts of ammonia? Are there any ways to minimize this slippage? The section should address this issue in more detail.

11

**Estimate of Actual Emissions from the Cogeneration Facility
Section 3.2-30**

This section discusses at length the accuracy of the EPA test method for PM. The section states that, "The study concludes that the EPA test method suffers from measurement error due to the small amount of particulate sample collected from the gas turbine exhaust. The EPA method was intended to collect samples over a one-hour period, however, the research shows that gas turbine tests must be run for up to six hours to collect enough material. Based on the information contained in the GE and Sierra Research studies, the actual particulate emissions from the facility are expected to be at least 60% less than the particulate emissions measured by the EPA reference method test."

12

The authors of the DEIS offer no comment or opinion as to the appropriateness of the applicants' rejection of the EPA test method. Nor is there anything included in this section from EPA as to why they believe that their testing method is appropriate. Rather, the authors of this DEIS simply adopt the statements made by the applicant in the ASC on this subject without any critique. At a minimum this section should offer additional information on views other than the applicants as to the appropriateness of the existing EPA test method as well as the EPA's comments on the method proposed by the applicant. The absence of this discussion does not aid in the understanding of the environmental impacts.



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Page 4

3.2.5 Greenhouse Gas

This section offers no discussion on impacts that global warming will have, and is already having, on the Northwest. While the exact impacts of a warmer region are not entirely known, scientists do know that certain impacts such as a decrease in snowpack, and the melting of glaciers is already occurring. The specific impacts of global warming on the Northwest should be at least minimally explored in this section.

13

3.2.6 Secondary and Cumulative Impacts**Cumulative Impact of Refinery and Cogeneration Facility Reductions**

This section states that, "[I]n combination with the removal of refinery utility boilers, the proposed cogeneration facility would result in an overall reduction in ambient concentrations of PM₁₀. These values represent the modeled impact of primary PM₁₀ emissions. Removal of the refinery boilers resulting from steam purchase from the cogeneration facility would significantly reduce NO_x emissions from the refinery, and would consequently also reduce secondary particulate in the airshed. The reduction in secondary particulate is expected to be greater than the increase in primary particulate emissions." Again, this statement is partly attributable to the rejection of the EPA test methodology on formation of PM₁₀. EPA's testing methodology should not be so readily rejected, or in the alternative their should be a balanced critique of the existing testing methodology prior to its rejection. This section should contain additional information on secondary and cumulative impacts using the existing EPA testing methodology.

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3.4.2 Impacts of the Proposed Action and 3.4.4 Secondary and Cumulative Impacts

There is no discussion in either of these sections on potential water quality issues such as impacts of increased salinity and temperature on the herring population, the age and condition of the existing diffuser, and potential cumulative impacts on water quality through the refinery NPDES permit revision process. To the extent that cumulative impacts are discussed they are given a cursory review, stating only that, "The cogeneration facility would add 190 gpm of treated wastewater to the Strait of Georgia at Cherry Point, which is an increase of about 8% over the current discharge from the BP Cherry Point Refinery. Although a relatively small increase, this adds to the overall burden to water quality of the Strait of Georgia." This "discussion" does nothing more than state the obvious. Please supplement this section to address the issues raised above.

15

Thank you for allowing CFE the opportunity to comment on the draft environmental impact statement.

Very truly yours,



MARY C. BARRETT
Senior Assistant Attorney General
(360) 664-2475

MCB:nt



Greater Vancouver Regional District
4330 Kingsway, Burnaby, British Columbia, Canada V5H 4G8

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November 3, 2003

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Allen Fiksdal, Manager
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ENERGY FACILITY SITE
EVALUATION COUNCIL

Dear Mr. Fiksdal

Re: Comments on the BP Cherry Point Cogeneration Project - Draft Environmental Impact Statement

As the technical lead organization for Canadian air quality agencies, we wish to advise EFSEC of our comments and concerns regarding the *BP Cherry Point Cogeneration Project - Draft Environmental Impact Statement*. These concerns have been identified by the *Interagency Technical Review Team* consisting of staff from the Greater Vancouver Regional District (GVRD), Fraser Valley Regional District (FVRD), B.C. Ministry of Water, Land and Air Protection, and Environment Canada, who reviewed the air quality section of the *Draft Environmental Impact Statement* as well as some additional information provided by the proponent.

The attached report present the issues that we believe were not addressed adequately in the DEIS and/or remain as main concerns for this project. A more detailed analysis of the DEIS and air quality related concerns/issues are provided in Attachment-A of the *Interagency Technical Review Team* report.

Thank you for the opportunity to comment on the proposed *BP Cherry Point Cogeneration Project - Draft Environmental Impact Statement*.

Yours truly,

A handwritten signature in cursive script, appearing to read 'Ken Cameron'.

for Ken Cameron
Manager, Policy and Planning

Attachment

cc Mike Nassichuk, Environment Canada
Hu Wallis, Ministry of Water, Land and Air Protection
Hugh Sloan, Fraser Valley Regional District

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***Interagency Technical Review Team Comments on the BP Cherry Point
Cogeneration Project – Draft Environmental Impact Statement
(October 29, 2003)***

SUMMARY

On September 5, 2003, the Draft Environmental Impact Statement (DEIS) for the proposed BP Cherry Point Cogeneration Project was issued by Washington State Energy Facility Site Evaluation Council (EFSEC). The *Interagency Technical Review Team* consisting of air quality experts from the GVRD, FVRD, Ministry of Water Land and Air Protection, and Environment Canada, met with BP Cherry Point representatives and their air quality consultants on September 15, 2003 to discuss air quality issues identified by the Canadian agencies, and how they were addressed in the DEIS. New information on modelled air quality impacts of the project (e.g. isopleths of ambient air concentrations) and impacts of startup/shutdown practices (which were not included in the Draft EIS) were provided during and after the September 15th meeting.

The following is a summary of issues that the *Interagency Technical Review Team* believe were not addressed adequately in the DEIS and/or remain as main concerns for this project. These findings are based on the review of the air quality section of the Draft EIS, pre-filed testimony, and discussions with the proponent and their air quality consultants:

- **Health Effects:** There is a substantial and growing body of evidence that suggests that adverse health effects would be predicted at particulate matter and ozone exposure levels currently experienced in the Lower Fraser Valley, below current air quality objectives. For example, Bates et al (2003) concluded that: “*Levels of some air pollutants, particularly PM_{2.5} and its wood smoke component, and ozone, in British Columbia are at levels which, on the basis of comparisons with international data, would be predicted to be causing adverse health effects,*” and went on to recommend that: “*...any improvement in air quality for PM or ozone would result in fewer negative health impacts.*” (See Attachment-A for further information.) In order to fully describe the health and environmental impacts of the proposed project, the final EIS should analyze the implications of this body of evidence with respect to the project. 1

- **Particulate Matter (PM) Emissions:** Due to the potential implications of the body of evidence mentioned above, and the fact that the *Canada-Wide Standards for Particulate Matter (PM) and Ozone* acknowledge this body of evidence and include commitments to “continuous improvement” and “keeping clean areas clean,” PM emissions from the proposed plant are an issue of potential concern. “Maximum Potential” emissions of primary PM from this project are estimated at 262 tons per year, and would be released almost entirely in the form of fine particulate (PM_{2.5}). “Expected” emissions which are considered as more representative of actual emissions from the proposed power plant are estimated at 232 tons per year. This has the potential to increase the overall PM₁₀ and PM_{2.5} emissions in the LFV airshed by 1.5% and 3%, respectively. The “expected” annual emissions presented in the DEIS, assumes 60% error in the EPA test reference method and subtracts an additional 149 tons per year of PM₁₀ from the annual emissions as “PM adjustment”. In the absence of additional scientific documentation, it would be difficult to justify such adjustments. 2

Comments on the BP Cherry Point Cogeneration Project - Draft Environmental Impact Statement
October 29, 2003

It is recognized that the retirement of the old refinery boilers will reduce emissions of other criteria air pollutants (e.g. NO_x and SO_x), which are precursors for fine particulate, and would help reduce the secondary PM formation in the atmosphere. However, there is uncertainty contained in the conversion rate that would affect the amount of secondary PM avoided (or formed) due to the reduction (or increase) in precursor emissions such as NO_x, SO_x and ammonia. This results in an uncertainty in the overall PM impacts of this project. A range of conversion rates should be examined in the final EIS to address the lack of literature on the subject and the uncertainty contained within the conversion rate assumptions. A more detailed analysis of primary PM emissions and secondary PM can be found in Attachment-A.

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Given the concern around PM, the final EIS should include a more thorough analysis of potential ambient concentrations of PM₁₀ and PM_{2.5} than contained in the DEIS. Specifically, although the DEIS presents modeling results for worst-case ambient concentrations of PM (at the worst-case location in Canada), we understand that the models used to generate these results did not take into account the formation of secondary particulate. Because of the potential importance of exposure of Canadian residents to PM at levels below current objectives, the final EIS should include scientifically credible (for this airshed) modeling of worst-case ambient primary and secondary PM concentrations (including secondary particulate formation from in-plume and ambient ammonia). In order to address the worst case, such modeling should continue to ignore any "refinery offsets" or "PM adjustments," as in the DEIS, especially for consideration of short-term exposures.

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- **Ammonia (NH₃) Emissions:** Ammonia emissions from the proposed plant are also an issue of potential concern. The use of selective catalytic reduction (SCR) control technology to reduce NO_x emissions, is expected to release nearly 175 tons per year of ammonia. While the proponent has provided information to indicate that the maximum predicted ammonia concentration is less than the Acceptable Source Impact Level (ASIL), it would be beneficial to also report the maximum predicted concentration in Canada. In addition, ammonia is a precursor to secondary particles (e.g. ammonium nitrate and ammonium sulfate) in the presence of NO_x and SO_x. As mentioned above, giving a consideration to the formation of additional ambient particulate due to this ammonia source would be useful when assessing the total ambient particulate concentrations (PM₁₀ and PM_{2.5}) resulting from the project.

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- **Start-Up Scenarios:** The DEIS modeled worst-case Canadian ambient concentrations of several pollutants. It is our understanding that these worst cases were defined from "maximum potential emission" scenarios, but that these scenarios did not include start-up scenarios. Additional information received from the proponent subsequent to the release of the DEIS suggests that for some parameters (e.g. nitrogen oxides and carbon monoxide), the worst-case scenario for short-term exposures in Canada may be a start-up scenario. Therefore we conclude that in order to most accurately describe the environmental impacts of the project, the final EIS should include revised ambient concentration modeling results for any parameter and "objective duration" (e.g. ≤ 24 hours) for which a start-up scenario is the worst-case scenario.

6

Comments on the BP Cherry Point Cogeneration Project - Draft Environmental Impact Statement
October 29, 2003

- **Airshed Emissions Context:** The DEIS presents estimated expected annual emissions attributable to the project, for several parameters. The final EIS would be more conducive to decision-making if these estimates were presented in the context of the estimated total emissions (for each parameter) in the Lower Fraser Valley / Whatcom County airshed. For example the final EIS might indicate the percentage of airshed emissions that the project would represent, similar to what the DEIS presently does for greenhouse gas emissions. These estimates are available from the Greater Vancouver Regional District's July 2003 *Forecast and Backcast of the 2000 Emission Inventory for the Lower Fraser Valley Airshed 1985-2025*.

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- **Mitigation Measures**

PM Emissions: Applicant's proposal to reduce refinery emissions through removal of existing refinery boilers will offset the emission of some Criteria Air Contaminants. On page 3.2-46, the DEIS states:

Enforceable conditions requiring removal of the refinery's three utility boilers within six months of the beginning of cogeneration facility operation could allow regulatory agencies to more fully take into account refinery emission reductions in the permitting and environmental review process.

To facilitate decision-making concerning this potential requirement, the final EIS could include revised worst-case ambient concentration modeling results for the above scenario (i.e. post removal of refinery boilers).

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The largest expected emissions reduction will be in NO_x emissions resulting in net reduction of 318 tons per year. PM_{2.5} emissions, however, which are linked to respiratory and circulatory diseases in humans, are expected to increase by 232 tons annually. This is a significant increase when compared to the overall PM_{2.5} emissions in the airshed, and will result in some increase in ambient PM_{2.5} concentrations. The Applicant proposed no mitigation measures to minimize the impacts of PM emissions from the operation of the proposed power plant.

9

Greenhouse Gas Emissions: As proposed, the project would emit more than two million tons per year of greenhouse gases to the atmosphere. The proponent company has committed itself to greenhouse gas emission reduction targets on a worldwide basis and proposed to offset GHG emissions from this project as part of BP's corporate (worldwide) GHG objective. Also, the Applicant provided an alternate GHG mitigation proposal for the cogeneration facility that would apply to the project if the facility changes ownership. Whether the facility ownership remains with BP or changes, a credible/verified documentation would help ensure that such offsets are occurring. While it is recognized that climate change is a global concern, local air quality benefits as well as other environmental and economic benefits could be realized by offsetting greenhouse gas emissions locally, within the airshed.

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A more detailed analysis of the DEIS and air quality related concerns/comments are provided in Attachment-A.

Attachment-A: Detailed Comments on the BP Cherry Point Cogeneration Project – Draft Environmental Impact Statement

The following findings are based on the review of the air quality section (3.2) of the Draft Environmental Impact Statement, pre-filed testimony of Brian R. Phillips (Exhibits 22.0, 22.1, 22.2, and 22.3), and discussions with the Applicant and their air quality consultant.

Overview of Maximum Potential and Expected Emissions

The following table summarizes the maximum potential emissions from the proposed power plant as well as the emission reductions (offsets) from the refinery that would result from the retirement of the existing steam boilers that currently supply steam to refinery processes.

Table 1.

	Maximum Potential Emissions (tons/y)				
	NO _x	CO	VOC	PM ₁₀	SO ₂
Power Plant Total ¹	233	158	42	262	51
Emission Reductions from Refinery ²	-499	-54	-3	-10	-7
Net Emissions	-266	104	39	252	44

¹Including emergency generator, firewater pump and cooling tower

²Note that the reductions from the refinery are based on the emission capacity of the refinery boilers, and not the emissions from current boiler operations.

The following table summarizes the emission of common air contaminants from the proposed power plant (maximum potential and expected), Sumas Energy 2, BP Cherry Point refinery, Whatcom County and the Lower Fraser Valley International Airshed.

Table 2.

	Emissions Comparison (tons/year)					
	NO _x	CO	VOC	PM ₁₀	PM _{2.5}	SO ₂
BP Cherry Point Cogeneration Project (Max. Potential) ¹	-266	104	39	252	252	44
BP Cherry Point Cogeneration Project (Expected-I) ^{1,2}	-318	27	25	232	232	43
BP Cherry Point Cogeneration Project (Expected-II) ^{1,2,3}	-318	27	25	84	84	43

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Sumas Energy 2 Generation Facility (Max. Potential)	145	88	153	209	209	69
BP Cherry Point Refinery (2000)	2,265	362	1,519	91	65	1,735
Emission Reductions from Refinery ⁴	-499	-54	-3	-10	-10	-7
Whatcom County (2000)	17,400	114,650	40,280	5,300	2,540	10,060
Lower Fraser Valley International Airshed ⁵ (2000)	99,900	481,930	111,200	15,360	8,960	18,900

¹ Emission reductions (offsets) from the refinery due to the removal of refinery steam boilers are taken into account for both the "maximum potential" and the "expected" emission scenarios.

² "Expected-I" emissions are based on operating conditions that are considered more representative of actual operation of the cogeneration plant where "PM adjustment" was not taken into account. Interagency Technical Review Team does not support the inclusion of "PM adjustment" in emissions unless scientific documentation from reputable sources such as US EPA is provided.

³ "Expected-II" emissions are based on operating conditions that are considered more representative of actual operation of the cogeneration plant where also the "PM adjustment" (-149 tpy) is taken into account. The Applicant claims that there is 60% error in the EPA test reference method that overestimates PM emissions from natural gas-fired turbines.

⁴ Potential emission reductions due to removal of refinery steam boilers.

⁵ Includes emissions from the GVRD, FVRD and Whatcom County.

The NO_x emissions are expected to be reduced with this project under both "Maximum Potential" and "Expected" operating conditions. This is mainly due to the retirement of existing refinery boilers that no longer will be needed when the cogeneration plant (providing the required steam for the refinery processes) begins operating. Emissions of all other common (criteria) air contaminants (CACs), however, are expected to increase with the cogeneration project. Emissions of carbon monoxide (CO), volatile organic compounds (VOCs) and sulphur oxides (SO_x) are very low when compared to local emissions as well as the overall airshed emissions. Therefore, no significant direct air quality impacts of these contaminants are expected in Canada. This is confirmed by the modelling which shows the predicted ambient concentrations to be very low compared to Canadian objectives. Particulate Matter (PM) emissions, however, appear to be significant – under both "Maximum Potential" and "Expected" conditions – and deserve special attention.

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PM Emissions

The proponent has included two different "expected" emissions scenarios for Particulate Matter. The first scenario assumes that the expected PM emissions will be 232 tpy (as shown in the table above). The second is known as the "PM adjustment" scenario which assumes that there is a 60% error (149 tpy) in the EPA test reference method and that the expected PM emissions will be 84 tpy (including refinery reductions) instead of 232 tpy. While the *Inter-Agency Technical Review Team* acknowledges the documentation provided by the proponent with respect to the accuracy of EPA Method PRE-4/202, it is the view of the *Team* that without additional scientific documentation from peer-reviewed third party sources or the EPA to support the evidence of error in the EPA test reference method, we will continue to evaluate the expected emissions from this facility without the PM adjustment.

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cont.

"Expected" PM₁₀ emissions of 232 tons per year would increase the overall Whatcom County and Lower Fraser Valley International Airshed (PM₁₀) emissions by 4.4% and 1.5 %, respectively. Assuming all PM is released in the form of PM_{2.5} the increase in the PM_{2.5} emissions would be as high as 9% and 3% of the overall emissions of PM_{2.5} for Whatcom County and the Lower Fraser Valley International Airshed, respectively.

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Overview of Secondary PM and Air Quality Issues

Secondary PM

The proponent has addressed the impact that the facility will have on secondary particulate matter (PM) formation. The sensitivity of the assumptions made about the percentage of NO_x and SO_x that gets converted to secondary particulate matter is significant to this issue. Depending on which conversion rate is used and whether 60% PM adjustment (-149 tpy) is taken into account, there can be a net decrease (-81 tpy) or a net increase (224 tpy) in overall (primary plus secondary) PM. If the "PM adjustment" is not taken into account, the overall PM balance is expected to range between 68 and 224 tpy (see table below). As stated previously, it is the view of the *Team* that "PM adjustment" should not be taken into account unless credible, scientific documentation (e.g. from US EPA) is provided.

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The *Inter-Agency Technical Review Team* discussed this issue with BP representatives in their meeting on January 29, 2003 and gave input with respect to conversion rates. It was felt that a range of conversion rates (~2% to 40%) should be examined in the final EIS to address the lack of literature on the subject and the uncertainty contained within the conversion rate assumptions. For the entire facility, there is a net decrease in NO_x and a net increase in SO_x (see "expected" emissions in the table above). Therefore, if a high conversion rate is used - as given in the DEIS (33% for NO_x, 20% for SO_x) - it will result in a large reduction in secondary PM from NO_x sources, but an increase in secondary PM from SO_x sources, resulting in a large net reduction in secondary PM and an increase of 68 tpy in overall PM balance. If a lower conversion rate, as suggested by the *Inter-agency Technical Review Team*, is used (10% for NO_x, 10% for SO_x), a net increase of 185 tpy in overall PM (primary plus secondary) would be expected from this facility. As shown in the following table, lower conversion rates (from NO_x and SO_x to secondary PM) would result in a higher overall PM balance.

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Table 3. Overall PM Balance for Three Different Scenarios/Conversion Rates

	Expected PM Emissions (tons/year)	Secondary PM from NO _x (tons/year)	Secondary PM from SO _x (tons/year)	Overall PM Balance (tons/year)
<u>Conversion Rate: 33 % NO_x and 20 % SO_x</u>				
Power Plant Total	242	104	21	367
Refinery Reductions	-10	-286	-3	-299
Net	232	-182	18	<u>68</u>
<u>Conversion Rate: 10 % NO_x and 10 % SO_x</u>				
Power Plant Total	242	31	10	283
Refinery Reductions	-10	-87	-1	-98
Net	232	-56	9	<u>185</u>
<u>Conversion Rate: 2 % NO_x and 4 % SO_x</u>				
Power Plant Total	242	6	4	252
Refinery Reductions	-10	-17	-1	-28
Net	232	-11	3	<u>224</u>

*It is assumed that NO_x emissions are 181 tpy (plus a refinery reduction of -499), and SO_x emissions are 51 tpy (plus a refinery reduction of -7 tpy). Also, no "PM adjustment" was taken into account. Secondary PM is assumed to be ammonium nitrate and ammonium sulphate.

Ambient PM Concentrations

Modelled concentration for maximum 24-hour PM₁₀ and PM_{2.5} in Canada (location with maximum impact) is 2.5 µg/m³. The worst-case increase in the 24-hour ambient PM₁₀ concentration at a Canadian location was less than 7% over worst-case background at the same location. Maximum change in 24-hour PM₁₀ concentrations for White Rock (0.52 µg/m³), Langley (0.36 µg/m³), Richmond (0.19 µg/m³), and Abbotsford (0.16 µg/m³) are predicted to be much lower than for the Canadian location with maximum impact (Table 5). A maximum annual PM₁₀ concentration of 0.2 µg/m³ was also predicted for the same location close to the Canada/US border. These concentrations are based on maximum potential emissions and did not

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take into account any "PM adjustments" or secondary PM formation/reduction into account. The modelled increases in the ambient PM₁₀ levels do not appear to be high for major residential areas.

Table 4. Comparison of Maximum PM₁₀ Concentrations in Canada (BP vs. SE2)

Facility Name	Averaging Time	Maximum PM ₁₀ Concentration in Canada ^{1,2} (µg/m ³)			Most Stringent Canadian Objective (µg/m ³)
		Change	Background	Total	
BP Cherry Point Cogen. Project	24-Hr	2.5	39*	42*	50
	Annual	0.2	13	13	30
Sumas Energy 2 Generation Facility	24-Hr	3.7	52	56	50
	Annual	0.4	15	15	30

* These numbers are revised using GVRD data

¹ BP Cherry Point: Highest concentrations in Canada predicted on the US/Canada border, 12 km north of project site. Source of data is DEIS (September 2003)

² Sumas Energy 2: highest concentrations in Canada predicted on Sumas Mountain, Abbotsford. Source of Data is SE2 Second Revised Application (June 2001)

Table 5. Increase in Maximum PM₁₀ Concentrations (BP Cherry Point Project)

Averaging Time	Increase in Maximum PM ₁₀ Concentrations at Various Locations* (µg/m ³)					
	Max. US	Max. Canada	White Rock	Langley	Richmond	Abbotsford
24-Hr	4.3	2.5	0.52	0.36	0.19	0.16
Annual	0.25	0.2	0.06	0.04	0.01	0.01

*Data in this table is based on information provided by the proponent at a meeting with the Interagency Technical Review Team on September 15, 2003.

Results of Calpuff modelling with secondary PM formation (i.e. 24-hour isopleths and maximum concentration) should be provided, in order to determine the combined effect of primary and secondary PM on ambient air quality. Current values reported in the DEIS are from the ISC modelling, which doesn't include secondary PM.

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Ambient Ozone Concentrations

Notably, the DEIS does not comment upon or address the impact of the proposed facility on ozone concentrations. Known to pose a health risk at current levels, ozone is a priority air quality issue in the LFV airshed and has been the focus of several scientific investigations and federal, provincial and regional air quality management initiatives.

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Start-Up Scenarios

The DEIS modeled worst-case Canadian ambient concentrations of several pollutants. It is our understanding that these worst cases were defined from "maximum potential emission" scenarios, but that these scenarios did not include start-up scenarios. Additional information:

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received from the proponent subsequent to the release of the DEIS suggests that for some parameters (e.g. nitrogen oxides and carbon monoxide), the worst-case scenario for short-term exposures in Canada may be a start-up scenario. Therefore we conclude that in order to most accurately describe the environmental impacts of the project, the final EIS should include revised ambient concentration modeling results for any parameter and "objective duration" (e.g. ≤ 24 hours) for which a start-up scenario is the worst-case scenario.

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Health Effects

There is a substantial and growing body of evidence that suggests that adverse health effects would be predicted at particulate matter (less than 2.5 microns) and ozone exposure levels currently experienced in the Lower Fraser Valley, below current air quality objectives. For example, Bates et al (2003) concluded that: "*Levels of some air pollutants, particularly PM_{2.5} and its wood smoke component, and ozone, in British Columbia are at levels which, on the basis of comparisons with international data, would be predicted to be causing adverse health effects,*" and went on to recommend that: "*...any improvement in air quality for PM or ozone would result in fewer negative health impacts.*" Bates, D.V., Brauer, M., Koenig, J. Q., *Health and Air Quality 2002 – Phase 1 – Methods for Estimating and Applying Relationships Between Air Pollution and Health Effects*, British Columbia Lung Association, 2003.

In 2001, Lower Fraser Valley Medical Health Officers stated that:

"Air pollution is an important public health issue and is linked to illness and death in the lower mainland and elsewhere. This is true despite the fact that current levels of air pollution in the lower mainland are generally stable or lower than they have been in the past and that levels of air pollution in the lower mainland are lower than other major cities in western North America." Copes, R., Blatherwick, J., Guasparini, R., Loewen, N., O'Connor, B., *Air Quality in the Lower Mainland: Patterns, Trends and Human Health*, South Fraser Health Region, 2001.

Vedal et al (2003) concluded from an analysis of data from Vancouver, British Columbia, between 1994 and 1996 that "*increases in low concentrations of air pollution are associated with increased daily mortality.*" Vedal, S., Brauer, M., White, R., and Petkau, J., *Air Pollution and Daily Mortality in a City with Low Levels of Pollution*, Environmental Health Perspectives, 111:1, 2003.

The body of evidence above suggests that the worst-case increases in ambient PM concentrations associated with the project would be statistically expected to lead to adverse health effects among some Canadian residents.

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Mitigation Measures

Section 3.2.7 in the DEIS describes the Applicant's proposal to mitigate air emissions during the construction and operation of the energy facility. Construction emissions will be limited to fugitive dust and emissions from construction equipment powered by gasoline and diesel

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engines. These emissions appear to be small and will only occur during the construction phase of the project. Emissions resulting from the operation of the power plant, however, appear to be significant (PM₁₀ and/or PM_{2.5} in particular) and should be addressed through proper mitigation measure.

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Selective Catalytic Reduction (SCR) – The SCR technology will potentially reduce the NO_x emissions from 9 ppm to 2.5 ppm by using ammonia. In addition to being toxic, the introduction of ammonia emissions (175 tons per year) through SCR has the potential to contribute to secondary PM formation in the atmosphere. This is considered as the major drawback of the proposed SCR technology.

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Refinery Steam Boilers – The cogeneration facility will provide steam for the refinery processes that are currently met by existing refinery steam boilers. Reducing the refinery emissions through removal of existing refinery boilers will help offset some of the Criteria Air Contaminant emissions. The largest reduction will be in NO_x emissions resulting in a net reduction of 318 tons per year.

On page 3.2-46, the DEIS states: “*Enforceable conditions requiring removal of the refinery’s three utility boilers within six months of the beginning of cogeneration facility operation could allow regulatory agencies to more fully take into account refinery emission reductions in the permitting and environmental review process.*”

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To facilitate decision-making concerning this potential requirement, the final EIS could include revised worst-case ambient concentration modeling results for the above scenario (i.e. post removal of refinery boilers).

Cogeneration Plant – The operation of the cogeneration facility is expected to increase PM_{2.5} emissions by 232 tons per year under “actual” (or likely) operating conditions. This is a significant increase when compared to the overall PM_{2.5} emissions in the airshed and can be expected to result in some increases in ambient PM_{2.5} concentrations. Although fine particulate matter (PM_{2.5}) are linked to respiratory and circulatory diseases in humans and considered the most harmful among the criteria air contaminants (CACs), the Applicant proposed no mitigation measures to minimize the impacts of PM emissions from the operation of the proposed power plant. EFSEC’s Site Certification Agreement required a similar facility (Sumas Energy 2) to offset 100% of particulate (PM) emissions from their operation. Offsetting PM_{2.5} emissions would help manage these harmful emissions and associated ambient impacts in our airshed where approximately 2.5 million people live.

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GHG Mitigation – According to the data provided in the DEIS (Table 3.2-25), the greenhouse gas emissions from the cogeneration project would be 5%, 37%, 58% and 61% lower than a natural gas fueled combined cycle combustion turbine, and conventional natural gas-fired, oil-fired and coal-fired boilers, respectively. This is mainly due to more efficient fuel utilization achieved by combined-cycle cogeneration plants as well as the use of a less carbon intensive fuel such as natural gas.

The Applicant proposed to mitigate the project’s greenhouse gas emissions as part of BP’s corporate GHG objective within the company’s worldwide operations. BP’s worldwide objective is to hold its net GHG emissions at the 2002 level through the year 2012. If the proposed

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cogeneration facility changed ownership in the future an alternate GHG mitigation scheme would apply. According to this proposal GHG reductions would be obtained by the facility owner or would be provided in the form of an annual payment to a qualifying organization (e.g. the Climate Trust) for 30 years, which is the assumed economic life of the project. This would offset approximately 20% of the greenhouse gases generated by this project. According to the DEIS, BC Hydro plans to offset 50% of GHG emissions from new natural gas fired power plants, and Seattle City Light targets 100% offset for all new fossil generating stations added to the City's energy mix.

Whether the facility ownership remains with BP or changes, EFSEC should ensure that a credible, verified documentation be provided for GHG offsets. Since offsetting greenhouse gas emissions within the airshed would offer additional local air quality benefits as well as other environmental and economic benefits, preference should also be given to local GHG offsets.

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Section 3.2.8 Significant Unavoidable Impacts: It is stated in the DEIS that "No significant unavoidable adverse impacts on air quality are identified." This project, however, has the potential to increase fine particulate ($PM_{2.5}$) emissions, which are linked to respiratory and circulatory diseases in humans, by 232 tons per year. The increase in PM emissions can be expected to result in some increases in the ambient concentrations of fine particulate. In addition, over 2 million tons of greenhouse gas emissions will be emitted from this project, annually. These would result in some unavoidable environmental impacts, unless the $PM_{2.5}$ (fine particulate) and the greenhouse gas emissions are offset properly.

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Specific Comments on the Air Quality Section (Section 3.2) of the DEIS:

Table 3.2-4 (p. 3.2-11) contains several errors which were discovered upon review of the Greater Vancouver Regional District's annual air quality reports for the years noted in the table. For ambient monitoring station 1, the 24-hour PM_{10} for 2001 is 39 (not 35), the 24-hour $PM_{2.5}$ for 2001 is 21 (not 19), and the 24-hour ozone for 2001 is 80 (not 76). For ambient monitoring station 2, the 24-hour $PM_{2.5}$ for 2001 is 19 (not 17) and the 24-hour ozone for 2001 is 84 (not 82). In the maximum column, 24-hour PM_{10} should be 39 (not 35), 1-hour CO should be 4060 (not 2900) and 1-hour ozone should be 166 (not 168). Of main significance is the increase in the maximum 24-hour PM_{10} to $39 \mu g/m^3$.

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Table 3.2-5 (p. 3.2-13) presents a summary of the GVRD air quality index based on a dataset limited to only one year. We feel it is more appropriate to consider at least three years of ambient air quality data for establishing current conditions, as is done in Table 3.2-4.

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There is an apparent disagreement between Tables 3.2.8 and 3.2.9, regarding sulfur dioxide and carbon monoxide concentrations. If this is not a true disagreement, then additional clarification would be helpful.

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Table 3.2-15 and Table 3.2-16 (p. 3.2-25) should also include the maximum 24-hour $PM_{2.5}$ concentrations in addition to the 98th percentile concentrations currently reported in the tables.

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Table 3.2-20 (p. 3.2-28) – Net Regional Change in [PM₁₀] Emissions is listed as -84. This should be corrected as +84. Also, this table needs to be re-organized to clarify the relationship between the rows (i.e. row 3 is the summation of row 1 and row 2; row 5 is the summation of row 3 and row 4).

**29
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Table 3.2-23 (p. 3.2-31) is confusing as presented. It is suggested that this table be re-organized to show the relationship between the rows (e.g. row 3 is the sum of row 1 and row 2, etc.). In addition, the effects of NO_x and SO₂ emissions/reductions on secondary particulate are calculated assuming that a one ton emission/reduction in NO_x or SO₂ results in a one ton change in secondary PM. It would be more appropriate to consider molecular weights in this determination, and to assume that the secondary PM is in the forms of ammonium nitrate and ammonium sulphate.

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